

THE INFLUENCE OF EXCITATION FIELDS ON VORTEX CORE DYNAMICS IN MICRON- SIZED MAGNETIC DISKS

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INTRODUCTION

Magnetization vortices in micron-sized magnetic disks have been of great interest because of potential applications in non-volatile memory devices. Theory predicts a rich spectrum of excitations, including the fundamental or gyrotropic mode, in which the vortex core describes a circular path around the center of the disk in response to field excitations. Experimentally, the vortex trajectory has been studied in time-resolved magnetic imaging experiments with conflicting results. The gyrotropic mode is observed in some experiments while in others a linear or elliptical trajectory is seen instead.

RESULTS

We have imaged the free vortex core motion in permalloy disks of 6 μm diameter using time-resolved x-ray photoemission electron microscopy at beamline 4-ID-C of the Advanced Photon Source. We obtain ~ 90 ps time resolution via a pump-probe scheme in which samples are grown on coplanar waveguides and pulsed electrically. The vortex core was biased in a constant field, and then we followed its motion after the field was removed.

CONCLUSIONS

We demonstrate that the trajectory of the vortex core motion depends on the magnitude of the excitation field. The vortex core exhibits a gyrotropic trajectory under low excitation fields, while under high excitation fields the core shows a linear trajectory. We find that if the initial displacement of the core is greater than $\sim 20\%$ of the disk radius, transient magnetic domains appear in the first 500 ps after the field is removed. These domain states then profoundly influence the subsequent motion. The core oscillation frequencies are consistent with theoretical predictions, regardless of the excitation amplitude.

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